US009471170B2

(12) **United States Patent**
Goertz et al.

(10) **Patent No.: US 9,471,170 B2**
(45) **Date of Patent: *Oct. 18, 2016**

(54) **LIGHT-BASED TOUCH SCREEN WITH SHIFT-ALIGNED EMITTER AND RECEIVER LENSES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 212 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **13/052,511**

(22) Filed: **Mar. 21, 2011**

(65) **Prior Publication Data**

US 2011/0163998 A1 Jul. 7, 2011

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/371,609, filed on Feb. 15, 2009, now Pat. No. 8,339,379, which is a continuation-in-part of application No. 10/494,055, filed as application No.

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(51) **Int. Cl.**
G06F 3/042 (2006.01)
G06F 3/041 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 3/0416*** (2013.01); ***G06F 3/042*** (2013.01); ***G06F 3/0421*** (2013.01); ***G06F 3/0425*** (2013.01); ***G06F 3/0428*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 3/042
USPC 345/156, 173, 175, 176, 179
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,243,879 A 1/1981 Carroll et al.
4,267,443 A * 5/1981 Carroll et al. 250/221

(Continued)

FOREIGN PATENT DOCUMENTS

EP 0601651 A1 6/1994
JP 11-232024 A 8/1999

(Continued)

OTHER PUBLICATIONS

Moeller, J. and Kerne, A., Scanning FTIR: Unobtrusive Optoelectronic Multi-Touch Sensing through Waveguide Transmissivity Imaging,TEI '10 Proceedings of the Fourth International Conference on Tangible, Embedded, and Embodied Interaction, Jan. 25-27, 2010, pp. 73-76. ACM, New York, NY.

(Continued)

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(57) **ABSTRACT**

A touch screen including a housing, a display mounted in the housing, a plurality of collimating lenses mounted in the housing along two opposite edges of the display and arranged along the two edges so as to be shift-aligned relative to one another, a plurality of light pulse emitters mounted in the housing that are spaced apart from and transmit light pulses through the collimating lenses of one of the two edges over the display, a plurality of light pulse receivers mounted in the housing that are spaced apart from and receive the light pulses through the collimating lenses of the opposite of the two edges, and a calculating unit, mounted in the housing and connected to the receivers, that determines a location of a pointer on the display that partially blocks the light pulses transmitted by the emitters, based on outputs of the receivers.

26 Claims, 103 Drawing Sheets